Requirements Specification

Robotics Safety

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1 Introduction

This document specifies the requirements for the Robotics Safety project that is a part of the course TSBB11 at LiU, held at CVL.

2 Purpose and goal

The purpose of the project is to develop a system that monitors the surrounding of industrial robots and allows humans to safely work side-by-side with them. The goal is to provide a system that meets the expectation of Yaskawa Nordic AB. The requirements of the project are all assigned to different sprints. The sprints are vividly defined and can be changed depending on how much time the different requirements take to fulfill.

3 Definitions

There are predefined safety zones for the surrounding of the robot and these will be used to decide whether the robot should continue to work as normal, slow down its working pace or simply stop.

4 System Overview

The system will consist of at least one kinect sensor that sends a depth image and a colour image to the computer. Together with geometric data about the robot from the controller it is possible to detect if any object is entering the region of interest.

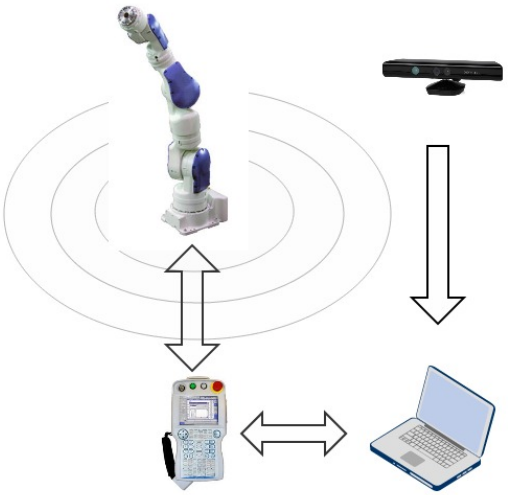

Figure 1: A picture of the robot, the kinect camera and the connecting computer.

5 Requirements

The requirements of the project are listed below. If a requirement is planned to be solved in a specific sprint, it is marked with the number of that sprint.

5.1 Product Requirements

This section describes the requirements of the finished product. These are the overall goals of the project.

1. Control of the robots working pace with respect to the closest moving object, sprint 3.

   The robot will slow down if a human being is approaching it and stop if someone gets to close.There will be three different zones around the robot. If a human is detected in zone 1, closest to the robot, the robot performs an emergency stop instantly. In zone 2 the robot will make a smooth stop and in zone 3 the robot will reduce its speed and continue its task.

   The safety zones are dynamical and will deform depending on the robot's orientation and speed.

2. Evaluation of the product's performance and reliability using an automatic system, sprint 4.

5.2 System Interfaces

These section describes how the functionality of the of the program will be split into modules.

3. There will be a module for segmentation of moving objects using statistical background models, sprint 2.

   It will be important to know what in the depth image is background and what are objects. To know this, object segmentation is needed. In this project, statistical background modelling will be used.

4. There will be a module for generating a 3D-model from robot data, sprint 2.

   The robot will give information about its orientation. This module will take that information and generate a 3D-robot model.

5. There will be a module for linking data from the 3D-robot model and the results from the segmentation of the depth image, sprint 3.

   This module distinguishes the robot from other moving objects in the images. This will be possible since a calibration between the coordinate system of the robot and the camera will be done. If it is necessary the colour of the robot will also be used to distinguish the robot from other moving objects.

6. There will be a module for evaluation of the complete system, sprint 4.

   This module will compute distances to moving objects and determine in which saftey zone an object is. From this there will be possible to display the number of moving objects in the robot's environment.

7. There will be a module for controlling the robot via the remote control, sprint 3.

   The robot will be controlled based on moving objects within the safety zones. This module will manage this, sending the correct signals to the robot based on what is found in the depth and color image.

8. There will be a module for real-time visualization of all 3D-data, sprint 3.

   There will be an 2D-environment where the robot and other 3D-data is visualized.

5.3 Hardware Interfaces

9. Camera setup specifications, sprint 2.

   The number of cameras and their positions will be specified.

5.4 Communication Interfaces

10. Data from the Kinect sensor should be available in the computer, sprint 2.

11. Data from the robot controller should be available in the computer, sprint 2.

5.5 Constraints assumptions and dependencies

These are the requirements that is assumed to be fulfilled for the system being able to work properly. None of them are categorized to a sprint.

12. The Kinect sensor should be placed in a position so that it can overview the robot. This ensures that a human being will not be able to approach the robot without entering the safety zones.

13. The system will not work in an environment that is to bright, there is an assumption of a reasonable amount of light.

14. The data used will always be the current input from camera and robot, i.e there will not be any module handling delays between inputs.

5.6 Functional requirements

This section describes the requirements of functionality for the subsystems and for the system in general.

15. The system will work if the kinect is placed such that occlusion is minimized.

16. Process information from robot controller and generate 3D-data, sprint 2.

17. Send control signal to the robot from computer, sprint 2.

18. Calibrate the coordinate system of the robot to the coordinate system of the Kinect, sprint 3.

19. Link the robot's 3D-data to the 3D-data from the Kinect sensor, sprint 3.

20. Determine the distance from the robot to the other found objects, sprint 3.

21. Evaluate the performance of the result automatically, sprint 4.

22. Detect a human being that is entering the area of interest, sprint 4.

23. Track objects in the image using statistical background models, sprint 2.